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Psoroptes Mites and Mule Deer (*Odocoileus hemionus*): Additional Notes from the San Bernardino Mountains, California

Vernon C. Bleich,[1,4] Jeffrey T. Villepique,[2] James H. Davis,[3] Steven G. Torres,[3] and Ben J. Gonzales[3]

[1]*California Department of Fish and Wildlife, Sierra Nevada Bighorn Sheep Recovery Program, 407 W. Line St., Bishop, CA 93514 USA*
[2]*California Department of Fish and Wildlife, P.O. Box 3222, Big Bear City, CA 92314 USA*
[3]*California Department of Fish and Wildlife, Wildlife Investigations Laboratory, 1701 Nimbus Rd., Rancho Cordova, CA 95670 USA*

Psoroptic scabies is caused by a mite (*Psoroptes* sp., Asghar et al., 2011; but, see Zahler et al. 2000) and affects bighorn sheep (*Ovis canadensis*) and cattle in the western United States (Singer et al. 1997). Similar to other diseases shared by native and domestic animals, psoroptic scabies has implications for the animal production industry and the health and conservation of wild ungulates (Roug et al. 2012). *Psoroptes* mites previously have been detected on mule deer (*Odocoileus hemionus*) sympatric with a population of desert bighorn sheep in New Mexico (Lange et al. 1980; Hoban 1990; Logan and Sweanor 2001) that was impacted substantially by that ectoparasite (Boyce and Brown 1991). Mite infestations among desert bighorn sheep in California are widespread and commonplace (Mazet et al. 1992; Clark et al. 1993), yet do not appear to result in severe clinical disease (Mazet et al. 1992).

Several of the populations of bighorn sheep examined by other investigators (Mazet et al. 1992; Clark et al. 1993) were sympatric with mule deer, as was the situation in the San Bernardino Mountains, California (Schaefer et al. 2000). Singer et al. (1997) investigated the prevalence of *Psoroptes* infestation among those species and domestic cattle in the southeastern part of that mountain range. Mule deer and bighorn sheep also were sympatric on the north-facing slope of the San Bernardino Mountains (Cushenbury Canyon, Bleich et al. 2009; Abella et al. 2011), and often share chaparral-dominated habitats in other parts of the transverse ranges and in the peninsular ranges of California (Bleich and Holl 1982). Psoroptic scabies was present in bighorn sheep captured in the San Bernardino Mountains at Cushenbury Canyon (Clark et al. 1988) and near Mt. San Gorgonio (Singer et al. 1997).

Singer et al. (1997) reported an absence of *Psoroptes* infestation among 15 mule deer captured near Mt. San Gorgonio. The small number of deer examined, however, limits the ability to make a conclusion based on negative detection of a pathogen or other anomaly (Hanley and Lippman-Hand 1983; Dougherty and McInerney 2009; Ho 2009). Singer et al. (1997) recognized a need to replicate results and recommended further investigation of pathogen-sharing among sympatric populations of mule deer and bighorn sheep. Therefore, we sampled additional mule deer from the San Bernardino Mountains to further explore the question of whether *Psoroptes* mites infest mule deer

[4] Present address: Department of Biological Sciences, Idaho State University, Pocatello, ID 83209 USA
Corresponding author: vern.bleich@wildlife.ca.gov

Table 1. Sample size and associated level of confidence that the prevalence (P) of *Psoroptes* mites was ≤ 10% in two proximate populations of mule deer, each numbering an estimated 200 individuals and sympatric with bighorn sheep in the San Bernardino Mountains, San Bernardino County, California, 1991–2004.

Source	Date	Approximate study centroid of area[a]	N	Level of confidence $P^b \leq 0.10$
Singer et al. (1997)	1991–94	34°04′N, 116°39′W	15	81%
This study	2002	34°21′N, 116°55′W	16	83%
This study	2004	34°21′N, 116°55′W	18	86%

[a] Latitude and longitude, WGS84 datum.

[b] Probability of exposure estimated according to the method of Wehausen (1987).

that are sympatric with bighorn sheep in that range, as originally posited by Singer et al. (1997).

We captured mule deer in the vicinity of Cushenbury Canyon during 2002 and 2004. We used a net-gun fired from a helicopter (Jessup et al. 1988); deer were physically restrained, and some individuals were transported by helicopter to a central base for processing (Monteith et al. 2011; Monteith et al. 2013), but those caught >10 km from that base were processed in the field. Each individual received prophylactic injections of penicillin (Sterile Penicillin Procaine G; Aspen Veterinary Resources, Liberty, MO, USA), Vitamin E (Vital-E®; Schering-Plough Animal Health Corporation, Summit, NJ, USA), and Vitamin E and Selenium (MU-SE®; Schering-Plough Animal Health Corporation, Summit, NJ, USA), and each was fitted with a VHF telemetry collar prior to release. Capture and handling procedures followed protocols developed by the California Department of Fish and Wildlife (CDFW) (Jessup et al. 1986) and were consistent with guidelines for acceptable field methods adopted by the American Society of Mammalogists (Animal Care and Use Committee 1998).

We conducted a thorough physical examination of each deer in an effort to detect clinical evidence of mite infestation, paying careful attention to the ears as described by Welsh and Bunch (1983). We searched both ears of each individual for evidence of dermatitis in the form of exfoliated epidermis, crusted serous exudate, or blockage of the meatus with hard, waxy material that would be consistent with clinical evidence of *Psoroptes* infestation (Welsh and Bunch 1983). We also collected deep ear swabs (Singer et al. 1997), which were examined microscopically for presence of *Psoroptes* mites. None of the mule deer captured in 2002 (n = 16) or 2004 (n = 18) revealed clinical evidence of *Psoroptes* infestation. Further, deep ear swabs collected from mule deer captured during September 2002 and later examined microscopically (n = 5) were negative for mites (K. R. Jones, CDFW, *in litt*, 14 March 2013).

It will be possible to establish an unambiguous absence of *Psoroptes* infestation in mule deer in the San Bernardino Mountains only if every individual can be sampled (Wehausen 1987). Nevertheless, using the method developed by Wehausen (1987), it can be stated with a high degree of confidence ($\bar{x}$ = 83.33% ± 4.023 [95% CI]; Table 1) that the infestation rate during each sampling period was ≤10%. Moreover, assuming that the infestation rates in each of the 3 sampling periods were independent, it is highly likely (P = 0.9945; $1-[\{1-0.81\}\times\{1-0.83\}\times\{1-0.87\}]$) that the infestation rate among the populations of mule deer examined was ≤10%.

Our failure to detect clinical evidence of psoroptic scabies or the presence of *Psoroptes* mites is consistent with the results of Singer et al. (1997), who detected no evidence of *Psoroptes* infestation among the mule deer they examined. Given the similarity of the level of confidence for each sampling effort, it is entirely plausible that no deer in the geographic areas investigated by us or Singer et al. (1997) were infested with mites. Our results provide additional evidence, as emphasized by Singer et al. (1997), that mule deer are an unlikely source of *Psoroptes* mites that infest bighorn sheep inhabiting the San Bernardino Mountains. Nevertheless, we cannot rule out other species of wildlife as potential sources of infestation of bighorn sheep by *Psoroptes* mites.

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